Analysis of pollutants evolved from combustion and pyrolysis of flexible polyurethane foam in a laboratory furnace

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Every year 30 million mattresses reach their end of life in Europe, being landfill the final destination of 60 % of this waste and incineration for the rest 40 %. In January of 2030, only 5 % of the total municipal waste could be landfilled; this fact together with the difficulties associated with mattresses recycling, make the incineration the best option for mattresses waste management. 42 % of the mattresses produced in Europe in 2013 were made from polyurethane, 45 % were spring mattresses, 11 % were latex mattresses and the rest made from other compounds. Bearing in mind this distribution, it is important to study the thermal degradation of flexible polyurethane foam (FPUF), one of the most used materials to produce mattresses.

In the present study, the evolved products from the combustion and pyrolysis of FPUF at 550 and 850 ºC have been analysed employing a horizontal quartz laboratory scale reactor. The study includes the analysis of ammonia, carbon oxides, light hydrocarbons, semivolatile compounds such as polycyclic aromatic hydrocarbons (PAHs), chlorobenzenes (ClBzs), chlorophenols (ClPhs), polychlorinated dibenzo*p*dioxins and dibenzofurans (PCDD/Fs) and “dioxin-like” polychlorinated biphenyls (PCBs) in duplicate.

High levels of ammonia were detected in pyrolysis runs at both temperatures, being more important those obtained at 550 ºC. However, nitrile compounds and hydrogen cyanide, which have significant health hazard and are characteristic products from incomplete combustion, presented the highest yields in the run at 850 ºC under N_2 atmosphere.

Naphthalene, acenaphthylene and phenanthrene were the most abundant compounds obtained in pyrolysis at 850 ºC. Apart from the 16 priority PAHs, more than 180 other semivolatile compounds have been detected, being benzonitrile and styrene the most important products in all runs. 75 different Ncontaining compounds have been detected at 850 ºC under N_2 atmosphere.

An increase of total yields of chlorobenzenes with the temperature was obtained in both, pyrolysis and combustion runs, being the pyrolysis run at 850 ºC, another time, the one with the highest yield. Despite the great difference between pyrolysis and combustion total yields, no significant variation in the congener profiles was detected, being mono-ClBzs the majority in the four runs.

Regarding the total yields of PCDD/Fs, combustion at 850 ºC presented the highest levels followed by pyrolysis at 850 ºC, combustion at 550 ºC and pyrolysis at 550 ºC. This trend agrees with the fact that ammonia compounds have inhibitory effect in dioxin formation. Less chlorinated compounds were the most abundant products in runs at 550 ºC in both atmospheres, whereas at 850 ºC the most chlorinated compounds presented more stability.

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